Progress in Nutrition 2019; Vol. 21, N. 1: 5-11 DOI: 10.23751/pn.v21i1.7497

Original article

The effect of acute L-arginine supplementation on repeated sprint ability performance

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Summary. *Aim*: The aim of this study is to determine the effect of acute L-arginine supplementation on repeated sprint ability performance in football players aged between 18-21 years. *Methods:* The study was conducted on 20 volunteer healthy male football players playing in the under-21 football team in the 1st league of Turkey. General characteristics of football players were questioned and their anthropometric measurements were taken. The study was performed as a double-blind placebo-controlled design. Players were randomly given 0.15 g/kg/day relative dosage L-arginine or placebo with 500 ml of water 1 hour before repeated sprint ability test (RSAT). The 12x20m RSAT protocol was applied in the synthetic turf football field with a recovery interval of 30 seconds between each sprint and the photocell system was used to determine running time. *Results:* The mean age of the arginine group is 18.30±0.48 years and the mean age of placebo group is 18.33±0.50 years. 85% of the players never used L-arginine, and any dietary supplements. Only the ninth sprint time of the 12 sprints performed after the supplementation was 5.24% faster than the placebo group in the arginine group ($p<0.05$). However, no difference was detected between the groups in terms of sprint decrement score, total sprint time, blood pressure and heart rate (HR) ($p>0.05$). *Conclusion:* In this study, the supplementation of acute L-arginine administered to players had no significant effect on HR, blood pressure and RSAT total sprint time and sprint decrement score.

Key words: Acute supplementation, football, L-arginine, repeated sprint ability.

Introduction

Athletes use a variety of ingredients or supplements to minimize the decrease or deterioration in performance due to the fatigue that occurs during exercise (1). L-arginine is an amino acid commonly used by athletes for the claim that it accelerates recovery in intensive exercise. L-arginine, one of the nutritional ergogenic supplements, is a precursor of nitric oxide (NO) and is used by athletes because of its vasodilator effect, accelerated recovery, increased blood flow to muscles, improved mitochondria biogenesis and increasing efficiency by effecting oxidative phosphorylation (2-4).

Although L-arginine, thought to have a positive effect on performance, is widely used by athletes, there are conflicting results showing that it has a sportive performance enhancing effect (5-7) or not (8-11). This study was conducted to examine the acute effect of relative dosage (0.15 g/kg/day) L-arginine supplementation on the performance of repeated sprint ability test (RSAT) of football players aged 18-21 years.

Material and Methods

This study was carried out with 20 healthy volunteer male players playing in U21 category (arginine group: n=10 and placebo group: n=9) of a football team in the 1st Professional Football League in Turkey in 2017-2018 season in Ankara, without any chronic disease, non-smokers, and have 4-6 trainings per week.

A player in the placebo group was left out of the study due to the injury he suffered during RSAT and data obtained from 19 players were assessed. Participants were asked to sign the informed consent form, and Helsinki Declaration was complied with during the study. Clinical Research Ethics Committee of Kirikkale University (No:12/16, 16 May 2017) was approved this study.

Procedure

During the execution phase of the study, football players were met two weeks before the test and all necessary information about the study was given. In this briefing, players were asked to continue their team nutrition and training programs until the morning of the test and not to use any supplements. In addition, they were asked not to consume caffeinated or alcoholic beverages during the last 24 hours before the test and not to perform exercise with high intensity during the last 48 hours. On the test morning, the players were met at the club facilities and their anthropometric measurements were taken before the supplementation. TANITA BC 418 (Japan) scale was used for body weight and TANITA portable stadiometer was used height measurements, and all measurements were made in accordance with the technique (12). Afterwards, heart rate measurements of players were taken with Polar brand short-range radio telemetry (Polar Team, Kempele, Finland). Blood pressure measurements were measured on the right arm twice after resting in sitting position after 10 minutes using Erka (Erka, Germany) brand manual blood pressure device by a nurse and the average of two measurements were taken.

Football players were given L-arginine or placebo orally at a dosage of 0.15 g/kg/day. They are randomly selected from the list numbered in the order of anthropometric measurement and divided into two groups as arginine and placebo groups. The study was conducted as a double-blind placebo-controlled design. L-arginine/placebo was prepared at a dosage of 0.15 g/kg/day by the dietitians to be given to the players and the participant number was labelled with supplementation code. Players were allowed to consume L-arginine/placebo supplementation with 500 ml of water one hour before RSAT. Dietitians who prepared L-arginine and placebo supplementation, did not share the list of supplementation with other researchers until all measurements were completed in order to ensure impartiality of measurements.

A standardized warm-up was made for the football player with oncoming test time, 45 minutes after the L-arginine/placebo supplementation. After self-paced low intensity running, the players were applied a warm-up that includes two sets of active dynamic stretching for the lower extremities (high knees, butt flicks, hamstring swings, carioca and sprint lunge) and three brief sprints. After warm-up, the football players performed a three minutes passive rest. Photocell system (Fusion Sport Smart Speed Photocell, Australia) was used for RSAT measurements. The starting and ending points of the 20 m distance determined for the test were measured and marked by the researcher using a tape measure. Photocells are positioned at both marked points at the waist level. RSAT was applied one hour after the supplementation in the surf synthetic turf football field with 30 seconds of recovery intervals between each sprint (jog run up to the last five seconds). Each sprint was started with a voice command, with a verbal stimulus of five seconds before the completion of the 30-second recovery interval after the sprint, ensuring that the football player is ready at the starting point. In RSAT, 30 second recovery interval between each sprint was followed by a digital stopwatch. After each sprint, the players' sprint times and heart rate (HR) values were recorded in the test data form. Football players did not consume food and beverages throughout RSAT. After finishing the test, the football player actively rested for five minutes and then rested in sitting position with soles of feet in contact with the floor for ten minutes. After fifteen minutes from RSAT, HR and blood pressure measurements were repeated. In order to determine the percentage of performance decrement (%) occurring in RSAT, the sprint decrement score formula was used. To assess the repeated sprint performance of the players in the study, 12x20m RSAT protocol, sprint decrement score and total sprint time comparisons were used (13,14).

Statistical Analysis of Data

Statistical analysis of the data was performed using the SPSS Windows 20 package program. Descriptive statistics are shown as mean± standard deviation

in normal distributed variables and the number (n) and percent (%) in nominal variables. The normal distribution of data was tested using Shapiro-Wilk test because the number of participants was below 50 in both groups. Data in text and figures are presented as mean and 95% confidence interval of the mean. In the data where the distribution in the statistics between the groups was normal, the mean differences were assessed by the independent samples t-test, which is a parametric test and where there is non-normal distribution in the data was assessed by non-parametric Mann-Whitney U-test. The results were considered statistically significant on the level of $p<0.05$.

Results

The players in the study (n=19) are all males and the mean age is 18.30±0.48 years in the arginine group (n=10) and 18.33±0.50 years in the placebo group (n=9). Of the football players; 85% have not used L-arginine before, 70% have no knowledge of L-arginine and have never used any nutritional supplements before. Arginine and placebo groups have similar characteristics in terms of general properties ($p>0.05$) (Table 1).

There was no significant change observed in systolic blood pressure (SBP) and diastolic blood pressure (DBP) values of football players in arginine and placebo groups before supplementation and 15 minutes after the test ($p>0.05$) (Table 2).

When the HR means of the football players arginine and placebo groups during resting, 12 sprint results and 15 minutes after the test were compared, no difference was found between the two groups ($p>0.05$) (Table 3, Figure 1).

When each sprint time for RSAT was compared between arginine and placebo group, there was no significant difference observed ($p>0.05$) between all sprint times (Figure 2), the fastest sprint time, the total sprint time (Figure 3), and the sprint decrement score (Figure 4), except for the 9th sprint.

Difference between RSAT 9th sprint time of arginine and placebo groups (Arginine: 2.941±0.092 sec vs. Placebo: 3.095±0.137 sec; difference: 0.154±0.045 sec) was significant ($p<0.05$). The 9th sprint time difference between the two groups was 5.24% less in favour of the arginine group. In addition, when the slowest sprint times (arginine: 3.015±0.067 sec vs. placebo: 3.172±0.170 sec) during 12 sprints in the arginine and placebo groups were compared, the difference between the two groups was significant ($p<0.05$).

Table 1. General characteristics of football players in Arginine and Placebo groups.

General Characteristics	Arginine Group (n=10)	Placebo Group (n=9)	p
Age (years)	18.30±0.48	18.33±0.50	0.879
Body Weight (kg)	72.04±6.82	75.06±9.42	0.441
Height (cm)	175.30±6.46	179.11±8.82	0.305
BMI (kg/m^2)	23.45±1.94	23.31±1.50	0.863
Body Surface Area (m^2)	1.87±0.11	1.94±0.17	0.343
Training Age (years)	9.40±2.07	10.44±2.35	0.321

Mean ± SD; BMI: Body Mass Index

Table 2. Blood pressure findings of football players in Arginine and Placebo groups before supplementation and 15 minutes after the test.

Blood Pressure	Arginine Group (n=10)	Placebo Group (n=9)	p
Before SBP	106.50±11.56	111.67±15.81	0.433
Before DBP	71.00±9.66	73.33±10.31	0.417
After SBP	105.00±5.27	105.00±7.07	0.820
After DBP	63.00±10.59	66.67±10.00	0.449

Mean ± SD; SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure

Table 3. Heart Rate findings of football players in Arginine and Placebo groups.

Heart Rate (HR)	Arginine Group (n=10)	Placebo Group (n=9)	p
Resting HR (beat/min)	66.10±2.73	65.56±3.88	0.731
12 Sprint Average HR (beat/min)	160.30±9.09	163.00±13.35	0.618
HR 15 minutes later (beat/min)	90.70±8.83	96.44±12.29	0.285

Discussion

This study is among the few studies (11) in the relevant literature evaluating acute effect of L-arginine

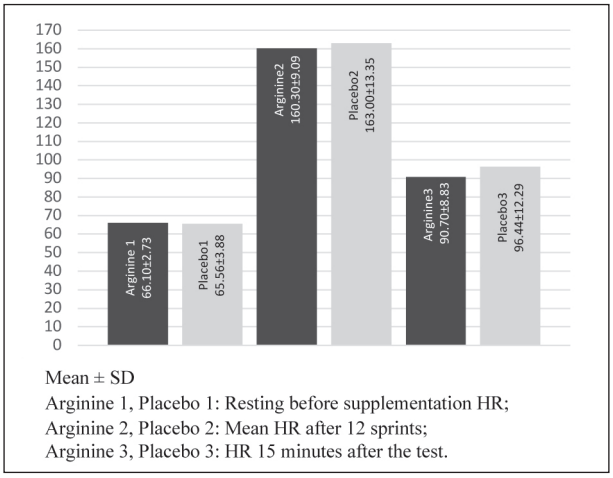

Figure 1. Heart Rate findings of football players in Arginine and Placebo groups.

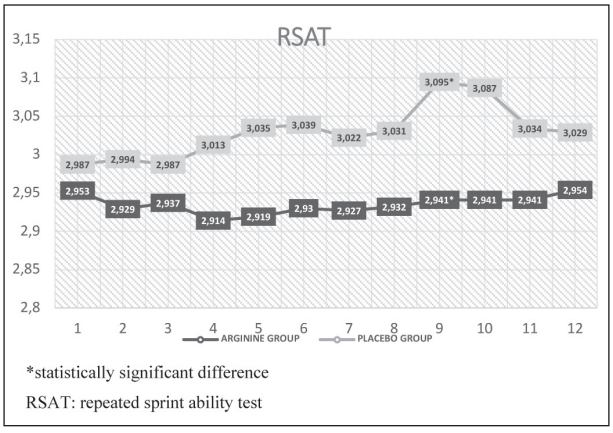

Figure 2. Each sprint times of football players in Arginine and Placebo groups.

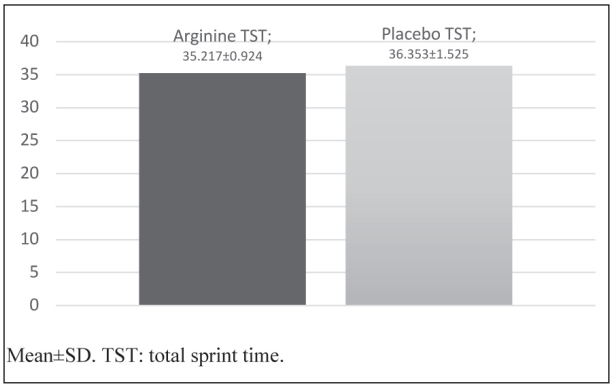

Figure 3. Total Sprint times of the players in Arginine and Placebo group.

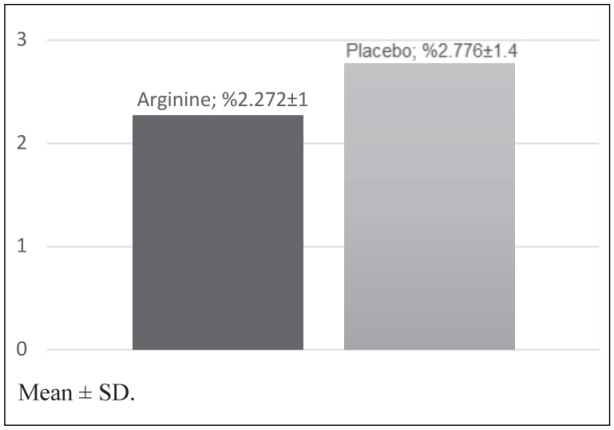

Figure 4. Sprint decrement score of football players in Arginine and Placebo groups.

supplementation on repeated sprint ability performance with a field based RSAT protocol.

When all HR measurements of the arginine and placebo groups were compared, there was no significant difference between the two groups. Similar to the results of this study, in the studies conducted by Yavuz et al.[7] on trained male wrestlers (0.15 g/kg/day L-arginine/ placebo); Sandbakk et al. 2015[10] on trained skiers (6 g L-arginine+614 mg nitrate, 614 mg nitrate or placebo); and Ermolao et al.[11] on trained football players (placebo=carbohydrate 26.7 g, placebo+caffeine 300 mg, placebo+arginine 3 g, placebo+BCCA 5 g and the mixture of all) reported no change in HR among the attempts. Although the dosages of arginine used in the aforementioned studies were different, the results showed that acute supplementation had no effect on HR in trained individuals.

In this study, there was no significant difference between arginine and placebo groups in blood pressure before supplementation and 15 minutes after RSAT, and L-arginine supplementation did not cause significant changes in blood pressure. Similarly, in a study on young elite male skiers, whom were given 6 g L-arginine+614 mg nitrate, 614 mg nitrate or placebo one hour before the test attempt, supplementation had no effect on arterial blood pressure (10). In another study, Yaman et al.[15], in their study conducted on football players playing in the university football team by giving them 6 g of L-arginine or placebo, reported a decrement in arterial blood pressure and an increase in

femoral artery diameter in the L-arginine reinforced group. On the other hand, Bailey et al.[5], in their study conducted on participants exercising recreatively, reported that 6 g L-arginine supplementation increased plasma NO synthase levels and lowered systolic blood pressure. The two tests conducted, seven days apart on trained male participants, indicated that arginine alpha-ketoglutarate (3700 mg) or placebo supplementation did not induce a significant change in blood pressure (16). In both studies (5,15), reporting an effect on blood pressure with arginine supplementation, the participants consisted of individuals who were not on high levels of training. In this study and the other aforementioned two studies (10,16), the reason for no change in blood pressure was due to the participants being trained and low dosages of L-arginine given.

There was no significant difference between arginine and placebo groups in RSAT fastest sprint, each RSAT sprint (except the 9th sprint), total sprint time, sprint decrement score. There was a significant difference between two groups in favour of arginine group in respect of only 9th sprint among 12 sprints during RSAT and the slowest sprint times. However, there was no significant difference in the other parameters (HR, blood pressure, total sprint time and sprint decrement score) between two groups that could support the cause of this difference. In comparison to arginine and placebo groups with regard to RSAT fastest sprint time, total sprint time and sprint decrement score, the supplementation of acute L-arginine in oral dosages of 0.15 g/kg/day had no effect on RSAT performance. Similarly, in the Wingate Anaerobic Test applied study conducted by Olek et al.[9] on moderately-trained healthy participants by administering 2 g single dosage of L-arginine 60 min prior to exercise, there were no changes in the performance improvement. Again, Sales et al.[8], in the study applied a test protocol with incremental intensity in cycling ergometer on trained volunteers, reported that 4.5 g arginine aspartate did not cause a difference in performance and had no effect of improving fatigue tolerance. On the other hand Yavuz et al.[7], in their study conducted on an incremental exercise protocol with male wrestlers in the cycling ergometer by administering a single dosage of 0.15g/kg/day L-arginine supplement, reported that there was no significant change in maximum heart rate, however the duration of fatigue was delayed in the arginine group. On the other hand, Hurst and et al.[6] stated that the use of relative dosage of L-arginine in male cyclists' cycling time-trial performance, and that the use of absolute dosages provided a reduction in the time of completion of the tests and an increase in the mean power output, and that the use of L-arginine in the relative dosage is more effective than the use of absolute dosages. Bailey et al.[5] also reported that the supplementation of 6 g L-arginine delayed fatigue in actively exercising individuals.

In the studies conducted with the trained participants, whether the uses of absolute or relative dosages of L-arginine supplementation had no effect on the development of performance. In the study conducted by Ermolao et al.[11], similar to our current study in terms of groups and test protocols used, the players were subjected to 11x20m RSAT with a recovery period of 20 seconds between each sprint and they were given 3 g arginine with carbohydrates, reported the supplementation did not cause any changes in RSAT performance.

When some studies with supplementation of chronic arginine was examined, the effect on physiological processes or exercise performances seemed different from the results obtained in acute supplementation. In studies in which chronic L-arginine supplementation was administered with different persons and at different dosages; changes were observed in muscle strength and mass (19), VO_2 max and increase in performance (20), increase in muscle strength and peak power (21) and prolongation of neuromuscular fatigue (22).

Studies that indicate that L-arginine supplementation has an effect on endothelial functions or physical performance are usually performed with individuals who are not trained highly or training at recreational level or administered with chronic L-arginine supplementation (23,24). Endothelial functions are associated with vascular health and exercise loads have NO bioactivity regulatory effect (24). In addition, the responses given to exercise loads by individuals with limited endothelial functions are more significant than those given by healthy sedentary/less-trained individuals, and that the metabolic responses shown by trained individuals through the supplementation of L-

arginine emerges more difficultly (according to the increasing training level) (24,25). In addition, the study participants' training levels, selected exercise/test protocol, supplementation dosage and the implementation of the supplementation whether acute or chronic is thought to affect the results of the study.

Conclusion

In this study, in which acute L-arginine supplementation to football players at a relative dosage of 0.15 g/kg/day, while a change was observed on the 9th sprint of 12 sprints in favour of the group administered L-arginine supplementation, no significant effect of supplementation has been observed on HR, blood pressure and RSAT performance. Considering that the football players in this study are trained individuals, the effect of oral administration of acute L-arginine on performance can be attributed to the fact that the metabolic responses in individuals with endothelial functions developed that are expected to occur are more difficult to detect than those with sedentary/recreational training.

Acknowledgements

For this study, no budget support or sponsorship has been received. The authors reported that they had no conflict of interest in this study. The authors owe a debt of gratitude to Erkan Tortu for his assistance in the performance test, to nurse Firuze Çevik Aydın for the blood pressure measurements, to dietitians Biriz Çakır and Sevinç Eşer Durmaz for the double-blind execution of the study by preparing the L-arginine supplementation in a relative dosage.

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